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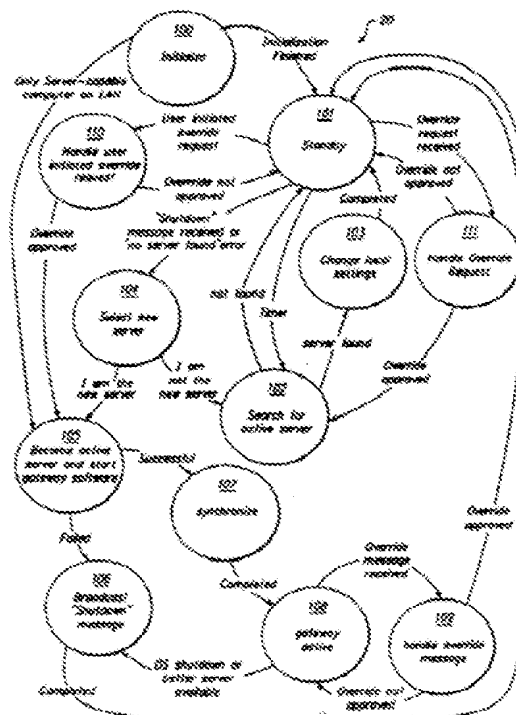
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(54) Title: METHODS AND APPARATUS FOR DYNAMIC INTERNET SERVER SELECTION

(57) Abstract

Methods and apparatus for dynamically selecting a computer on a local area network to become a server providing shared access to a wide area network, such as the Internet, to all of the computers on the local area network is disclosed. A server (101–103) maybe selected from among any of the computers on the local area network that is currently available (i.e., powered on), and capable of establishing a connection to the wide area network. If the current server shuts down, a new server may be selected (104–105) and started with only minimal impact on the other computers on the local area network, which are automatically reconfigured to use the new server to route network traffic to the wide area network.

METHODS AND APPARATUS FOR
DYNAMIC INTERNET SERVER SELECTION

Field Of The Invention

The present invention relates generally to
5   computer networking, and to establishing a connection
to a wide area network, such as the Internet, that is
shared by a small number of computers in a home
environment.

Background Of The Invention

10   The explosive growth of the Internet that has
occurred over the past few years has made the Internet
and the World Wide Web (WWW) an increasingly important
means for communication and distribution of
information. Although much of the growth of the
15   Internet has occurred due to its uses in education,
research, and business, many households are now
purchasing computer equipment and establishing Internet
connections. As increasing numbers of households and
families gain access to the Internet, numerous
20   services, such as entertainment and shopping, are
becoming available to serve the needs of these users.
Home users are already becoming the predominant
population of Internet users, and will further increase

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in numbers as the services available to home users
become more numerous and attractive.

At the same time that increasing numbers of
home users are gaining access to the internet, the
5   price of computer equipment is rapidly decreasing.
During the past year, personal computer systems priced
at under $1000 were the fastest growing segment of the
personal computer market. Almost all of these
inexpensive computers come with a pre-installed high-
10   speed modem and software for connecting to the
Internet. With the availability of such inexpensive
computers, it is not uncommon for households to have
multiple computer systems, each capable of establishing
a connection to the Internet.

15   The equipment necessary to connect multiple
computer systems together to form a local area network
(LAN) has also become inexpensive and simple. Many
home computers are now equipped by the manufacturer
with a standard network interface. Low cost add-on
20   network interface cards and network hubs are also
readily available. Setting up a LAN in the home is an
attractive option for households having multiple
computer systems, as it permits many resources, such as
printers or storage space to be shared between all of
25   the computers on the LAN. Moreover, manufacturers of
other types of home equipment, such as home security
systems, home control systems, audio and video
equipment, and appliances are starting to incorporate
network interfaces into their products. Already, many
30   new homes are being built with the wiring for a LAN
built-in, and it is expected that over the next decade,
many more households will install a LAN.

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Additionally, with the potential growth of
home LANs, numerous networking technologies have been
developed to make it easier to install a LAN in a home
environment. These include technologies that can
5   connect a LAN through preexisting wiring in a home, for
example, by sending LAN traffic across power lines or
home telephone lines. Also, numerous wireless LAN
technologies that may be appropriate for home use have
been developed, such as infrared and low-power RF LANs.
10 As this type of equipment becomes widely available at a
relatively low cost, it is expected that household LANs
will become commonplace.

Gaining access to the Internet through a
single computer is relatively simple. A large number
15 of Internet service providers (ISPs) provide dial-up
accounts that permit virtually unlimited low-speed
access to the Internet for a modest monthly fee. All
that is typically needed to connect to the Internet
through an ISP is a personal computer equipped with a
20 modem, a telephone line, and software (that typically
is pre-installed on the computer system) for accessing
the Internet through the ISP.

The speed of the modem typically determines
the speed of the connection to the Internet, and is
25 currently less than 56,000 bits per second. Over the
next few years, various types of higher speed
connections, such as cable modems or digital subscriber
lines, capable of transferring more than a million bits
per second, are expected to become widely available for
30 home use at a relatively low cost.

In the past, dial-up connections typically
provided access to the Internet to only a single
computer at a time. Connecting multiple computers to

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the Internet required multiple telephone lines, and
multiple ISP accounts. The monthly costs of
maintaining multiple telephone lines and ISP accounts
made this option prohibitively expensive for most
5   households. As a result, even if a household had
multiple computers, each with a high-speed modem, only
one of these would typically be connected to the
Internet through an ISP at any given time.

Recently, it has become possible to share a
10   single dial-up connection to the Internet with all the
computers connected to a LAN by using "gateway
software." The two widely available types of gateway
software are called "proxy server" software, and
"network address translation" software. Proxy server
15   software works by providing an intermediary network
server between the Internet and the LAN. Computers on
the LAN are configured to send their requests to the
proxy server software running on one particular
computer on the network. The proxy server software
20   then sends the request to the appropriate place on the
Internet, receives any response, and sends the response
back to the appropriate computer on the LAN. Thus, the
proxy server interposes itself in every communication
between a computer on the LAN and the Internet.

25   Network address translation software works in
a manner similar to proxy server software, but is
somewhat more transparent to the other computers on the
LAN. Network traffic addressed to computers outside of
the LAN is directed to the network address translation
30   software, which reroutes the network traffic to the
Internet. The addresses of network traffic received
from the Internet in response to requests made by

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computers on the LAN are translated to reroute the
traffic to the appropriate computers on the LAN.

Both proxy server software and network
address translation software are commercially available
5   from numerous vendors, and may be run on a wide variety
of platforms. One popular proxy server software
package for use with Microsoft's WINDOWS 95 operating
system is WINGATE, produced by Deerfield.com, of
Gaylord, Michigan. A popular network address
10   translation software package for use with Microsoft's
WINDOWS 95 operating system is SYGATE, produced by
SyberGen Incorporated, of Fremont, California.

Using such software, one of the computers on
the network (hereinafter referred to as the "server")
15   establishes a connection to the Internet (e.g. using a
modem and ISP), and permits the other computers on the
LAN to access the Internet through the server.
Typically, only one of the machines on the LAN is
designated as the server, and only the server may
20   normally establish a connection to the Internet.

One drawback of this arrangement is that the
software typically requires that one of the computers
be designated as a server, and the server may not be
easily changed once designated. Since all of the
25   computers on the LAN rely on the server for their
internet connection, if the server is down (e.g.
powered off or temporarily disconnected from the LAN),
none of the computers on the LAN are able to access the
Internet. Similarly, if the server stops functioning
30   (e.g. due to a software problem or a system crash)
while other computers on the LAN are using the server
to access the Internet, all of the Internet connections
are immediately lost.

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These difficulties are easily overcome in a
small business environment, where it is common to
dedicate a specific computer to performing the tasks of
a server. The server is typically not used for any
5   other functions (aside from sharing of other network
resources), and runs continuously. The server is also
typically configured with a professional, stable
operating system, and may be configured to run only a
small set of carefully selected software packages that
10 are known to be stable, and are unlikely to encounter
incompatibilities or to cause system crashes. It is
also not uncommon for small businesses to hire a
computer professional to make certain that their server
is properly configured, and continues to function.
15   Conditions typically are very different in a
home environment. For example, even if the household
owns several computers, rarely is one of them dedicated
to being a server. The computers used in the home are
often turned off during non-use, so there is no
20 guarantee that any particular computer will be powered
on and thus available for use as a server.
Additionally, many home users run somewhat unstable
consumer-level operating systems on their computers,
and also may run a wide variety of software, increasing
25 the probability of incompatibilities, system crashes,
and other software-related problems. It is difficult
to use typical gateway software in such an environment,
since no one computer on the LAN can be reliably
designated as the server.
30   In view of the above, it would be desirable
to provide a means for dynamically selecting which of a
number of available computers on a LAN should be used
as a server to provide LAN access to the Internet.

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It would also be desirable to provide a means
for dynamically and transparently switching between
servers when the computer that is currently acting as
server is shut down.

5   Summary Of The Invention

It is an object of the present invention to
provide a means for dynamically selecting which of a
number of available computers on a LAN should be used
as a server to provide LAN access to the Internet.

10   It is also an object of the invention to
provide a means for dynamically and transparently
switching between servers when the computer that is
currently acting as server is shut down.

These and other objects of the present

15   invention are achieved by providing "server selection
agent" software that works with gateway software to
dynamically select and switch between servers. The
software is designed to reduce the difficulties
encountered when running a server in a home environment

20   by permitting any one of a number of modem-equipped
computers on a LAN (i.e. most home computers) to become
a server.

The software first searches the LAN to see if
there is already an active server. If no server is

25   found, then the software selects which of the available
computers on the LAN should become the server. Once
the selection is made, the computer that was selected
as the server starts the gateway software, and the
other computers route their Internet traffic through

30   the selected server. When the selected server shuts
down, the computers on the LAN choose a new server from

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among the available computers, and resynchronize their
network traffic to use the new server.

Except in certain special override
conditions, this entire process may be accomplished in
5   a manner that is transparent to the users of the
computers. Users of the computers on the LAN simply
run their Internet-capable software as if they had a
permanent connection to the Internet. The server
selection agent software and gateway software run in
10   the background, and automatically handle all of the
details of selecting a server, connecting to an ISP to
gain access to the Internet, routing network traffic
between the LAN and the Internet, and dynamically
switching between servers.

15   Brief Description Of The Drawings
The above and other objects and advantages of
the present invention will be apparent upon
consideration of the following detailed description,
taken in conjunction with the accompanying drawings, in
20   which like reference characters refer to like parts
throughout, and in which:
FIG. 1 shows a LAN on which the methods of
the current invention may be used;
FIG. 2 shows a state diagram of a preferred
25   embodiment of the present invention; and
FIG. 3 shows a state diagram of an
alternative preferred embodiment of the present
invention.

Detailed Description Of The Invention
30   Referring to FIG. 1, typical home or small
office LAN 10 is described. Each of computers 12 on

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LAN 10 includes a network interface card and a modem.
Computers 12 are coupled to LAN 10 through their
network interface cards, and through network hub 14,
which interconnects all of the devices on LAN 10.

5   Each of computers 12 has an associated modem
(e.g. an internal modem) or other communications device
through which the computer can connect to a wide area
network. For purposes of this application a wide area
network (WAN) comprises any network or communications
10   system outside of the LAN. It also will be evident to
one skilled in the art that a connection to a wide area
network may be established either directly, or through
an intermediary network (LAN or WAN).

          Typically, computers 12 will establish a
15   connection to the Internet (or other WAN) by connecting
to ISP 16 through public telephone line 18. Because
LAN 10 is being used in a home or small office, all of
computers 12 share a single public telephone line 18,
so only one of computers 12 may use its modem to
20   connect to ISP 16 (or any other service) at any given
time. Other network capable devices, such as printer
17 may also be connected to LAN 10. Additionally,
computers without modems, such as computer 19, may be
connected to LAN 10. Such computers may not be
25   connected to public telephone line 18, and may not
establish a connection to ISP 16.

          In a typical previously known LAN, only one
of computers 12 on LAN 10 could be connected to the
Internet through ISP 16 at any given time. Whichever
30   one of computers 12 was connected would block any of
the other computers on the LAN from using public
telephone line 18 and the Internet account on ISP 16.
The development of gateway software, however, such as

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network address translation software or proxy server
software, permits all of the computers on LAN 10 to
share public telephone line 18 and access to ISP 16.
The gateway software usually is installed on one of
5   computers 12, which then functions as a designated
server. All of the other computers 12 and computer 19
are configured to route any traffic to the Internet
through the designated server containing the gateway
software. Only the designated server normally uses its
10   modem to connect to ISP 16, and if the server is shut
down or disconnected from LAN 10, all of the other
computers and devices on LAN 10 become unable to access
the Internet.

          In accordance with the principles of the
15   present invention, server selection agent software is
provided that enables any of computers 12 to be
dynamically selected as the server. The server
selection agent software of the present invention may
be included as part of an operating system, or may be a
20   separate software application. In either case, the
server selection agent software is installed on all of
computers 12 and on computer 19. Additionally, gateway
software is installed on all of computers 12, since any
of computers 12 could potentially become the server.

25   When any of computers 12 or computer 19 needs
access to the Internet, a server is selected from among
the available computers 12. Computer 19 cannot be
selected as a server, because it does not have a modem,
and cannot establish a connection to ISP 16.

30   If the server is shut down or disconnected
from the network, the other computers select a new
server from the available computers 12, and reestablish
their connections to the Internet through the new

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computer 12 selected to function as the server. In a
preferred embodiment, the server may also be changed if
a new one of computers 12 becomes available that would
be a better server (e.g. because it has a faster modem)
5   than the current server. Only if none of computers 12
are available, such as if they are all powered off,
would other computers (e.g. computer 19) or devices on
LAN 10 be unable to access the Internet.

       A preferred embodiment of the server
10 selection agent software of the present invention also
permits the user of one of the computers to request
that his or her computer become the server. This may
be useful, for example, if the user wishes to connect
to a different ISP than the one that is currently in
15 use by the server. If this "Override" mode is used, a
message is displayed on each of the active computers on
LAN 10, asking permission to switch servers. If all
the users of the active computers on LAN 10 consent by
selecting an "OK" option in the message, the server is
20 switched, and all of the computers on LAN 10 reroute
their Internet traffic through the new server (i.e.
they become "clients" of the new server).

       It will be apparent to one skilled in the
relevant arts that the modems in computers 12 may be
25 replaced with cable modems, ISDN modems, or digital
subscriber line modems, and public telephone line 18
may be replaced with other communications technology,
such as a cable line, an ISDN line, or a digital
subscriber lines. It will also be apparent that
30 computers 12 may not all be identical. Some of
computers 12 may be faster than others, or have faster
modems. Some of computers 12 may be connected to ISP
16 through, for example, a cable line, while others of

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computers 12 are connected to ISP 16 through public telephone line 18.

Other configurations having multiple public telephone lines (or other communications lines) may

5 also be used. With multiple telephone lines, it is possible to have more than one active server, and each of the client computers may select one of the active servers to reroute its Internet traffic. Alternatively, each of the computers may connect to

10 more than one active server, to provide additional network bandwidth.

Additionally, the "hub and spoke" configuration of LAN 10 is for illustration only. Other network configurations also are possible, and may

15 not require use of network hub 14. Additionally, although LAN 10 typically comprises standard 10Base-T or 100Base-T connections, it could also comprise connections made via power lines, telephone lines, wireless connections made via infrared or RF

20 transmission, or any other type of network connection. The principles of the present invention may be applied equally to any of these configurations, and should not be seen as limited to the configuration of LAN 10 shown in FIG. 1.

25 Referring now to FIG. 2, a state diagram of a preferred embodiment of the server selection agent software of the present invention is shown. This software is installed on all of the computers on a LAN, either as a part of their operating systems, or as a

30 separate application, and starts executing on a computer when the computer's operating system is started. Server selection agent software 20 normally executes in the background, and interferes only

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minimally with other software executing on the
computer. A typical computer user may not even be
aware that server selection agent software 20 is
executing. Optionally, the software may display a
5   small icon on the screen of the computer on which it is
executing to provide an indication of the current
status of the software. By executing a separate
monitoring program, a user may be able to receive more
detailed information on the status and functioning of
10   server selection agent software 20.

Execution of server selection agent software
20 starts in state 100. In state 100, a powered-on
computer, hereinafter called the "local computer,"
performs initialization, and establishes its presence
15   on the LAN. This involves steps of broadcasting a
initialization message to all other computers on the
LAN, the initialization message containing information
on the capabilities of the computer, such as the modem
speed of the associated modem, and the CPU speed. The
20   local computer then waits a short time to receive
messages from all of the other active computers on the
LAN detailing the capabilities of those machines.

In a preferred embodiment, the information
broadcast during the initialization step includes
25   information on the speed of any modems or other
communication devices that the local computer may use
to establish a connection to an ISP, and information on
the overall system speed of the computer. This
information is typically gathered once, when the
30   software is installed. Information on modems or other
communications devices may be provided by the user
during installation, or may be automatically
determined. Information on the overall system speed of

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the local computer may be determined by executing a
benchmark program designed to test how well the
computer will perform as a server. This information
may be updated whenever significant changes are made to
5   the computer, such as when new hardware is installed.

If the local computer receives no messages
from other computers on the LAN, or receives messages
only from computers that cannot become a server (e.g.
because they do not have a modem), it concludes that
10   there are no other currently active computers capable
of becoming a server. In this case, if the local
computer is capable of becoming a server, it switches
to state 105 and becomes the currently active server.
If none of the active computers on the LAN, including
15   the local computer, are capable of becoming a server,
an error message is displayed, and the local computer
switches to state 101. Under more normal conditions,
when the local computer receives information on the
capabilities of other currently active computers on the
20   LAN, the local computer switches to state 101.

State 101 is a standby mode, where the
software waits for some event, such as a timer message
or broadcast message from other computers on the LAN to
cause it to transition to a different state. Since
25   state 101 requires little or no processing, and
software 20 spends most of its time in state 101, the
processing demands placed on a computer by software 20
are minimal.

In state 101, when a timer event occurs,
30   which preferably happens at one minute intervals, the
local computer enters state 102, which searches for an
active server. If a "Shutdown" message is received,
the local computer transitions to state 104, where a

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new server is selected. The local computer may also
transition to state 104 if a "no server found" error
occurs, as a result of the local computer repeatedly
searching for an active server without finding one. If
5   the user initiates an override request, described in
detail hereinafter, the local computer transitions to
state 110, to handle the override request. If the
local computer receives an override request broadcast
in state 101, it transitions to state 111, to determine
10 whether the override request is approved.

State 102 searches the LAN for an active
server. This may be achieved by the local computer
broadcasting a network message to all computers on the
LAN requesting that they respond if they are the active
15 server. If none of the computers responds to the
request within a reasonable time (typically less than a
second), then no server has been found, and the local
computer displays an error message indicating that no
active server could be found, and returns to state 101.
20 If another computer responds that it is the active
server, the local computer transitions to state 103.

It should be noted that the periodic
searching for a server shown in FIG. 2 in the operation
of states 101 and 102 could be changed without
25 departing from the invention. For example, the active
server could broadcast a message identifying itself at
regular intervals, rather than having all of the
computers on the LAN search for the server
periodically.

30 In state 103, the local computer adjusts or
maintains local software settings to direct network
traffic to the proper active server, and returns to
state 101.

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In state 104, a new server is selected. In a preferred embodiment, this involves the local computer examining the capabilities of all active computers on the LAN, and applying rules to determine which of the
5   computers should become the server. Since all of the computers on the LAN apply the same criteria to determine which of them should become the server, and all of them have the same information on the capabilities of the computers on the LAN, all of the
10   computers will make the same selection.

If it is determined that the local computer should become the server, then the local computer transitions to state 105 and becomes the active server. Otherwise, some other computer on the LAN becomes (or
15   remains) the server, and the local computer transitions to state 102, to search for the active server.

In one embodiment, the rules that determine which of the computers should become the server may be relatively simple. First, to become a server, a
20   computer must have a modem or other communication device with which it can establish a connection to an ISP. If the local computer has no modem, it cannot be the active server. Next, the computer with the fastest modem should become the active server. If the
25   information on capabilities indicates that any of the computers on the network has a faster modem than the local computer, then the local computer should not become the active server. Next, if there was a tie on modem speed, then the computer with the highest overall
30   system speed should become the server. If the information on capabilities indicates that the modem speed of the local computer is the same as at least one other computer on the LAN, and the system speed of the

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local computer is less than another computer on the LAN
having the same modem speed, then the local computer
should not become the active server. Finally, in the
event that there is a tie on both modem speed and
5   overall system speed, then the computer with the lowest
network address is selected as the server.

It will be evident that there are many other
rules that could be applied to determine which computer
should become the server. The determination could be
10   made, for example, based a weighted sum of the
information on the capabilities of each computer on the
LAN. Alternatively, other capability information, such
as average actual throughput when connected to the ISP
could be used as a factor in deciding which computer
15   should become the active server. Additionally, the
selection process could be done by a single computer,
such as the currently active server, rather than being
done simultaneously on all of the active computers on
the LAN.

20   In state 105, the local computer becomes the
active server by starting the gateway software. In a
preferred embodiment, the gateway software comprises a
modified version of a network address translation
software package, such as SYGATE, by SyberGen
25   Incorporated, of Fremont, California.

Alternatively, the gateway software may
comprise proxy server software. Proxy server software
is somewhat less preferred, because it is more
difficult to configure. If proxy server software is
30   used, then server selection agent software 20 should be
modified to act as a local proxy server that runs on
every computer on the LAN, and redirects messages to
the "actual" proxy server software (i.e. a proxy

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cascade) running on the selected server, that in turn
redirects network traffic to the Internet. This
indirect approach avoids the need to reconfigure all of
the Internet capable software on the computer every
5   time the server changes.

In one embodiment, the gateway software is
modified for use with server selection agent software
20 so that the gateway software and server selection
agent software 20 can communicate with each other, and
10 (optionally) so that the gateway software can shut down
when an override request is processed, or when the
rules indicate that a better server has become
available. Alternatively, server selection agent
software 20 may use standard operating system services
15 to monitor unmodified gateway software, or to shut the
gateway software down when necessary.

If the gateway software fails to start, the
local computer transitions to state 106, in which a
"Shutdown" message is broadcast. The local computer
20 then transitions back to state 101. If the gateway
software starts successfully, the local computer
transitions to state 107, which synchronizes network
traffic between the new server and the other active
computers on the LAN. The local computer then
25 transitions into state 108.

State 108 is a state in which server
selection agent software 20 interacts with the gateway
software. If a remote or local Internet request is
received and the server is not already connected to the
30 ISP, a connection is established. When notice is
received that the operating system is shutting down
(e.g. because the user is shutting down the computer),
the local computer transitions to state 106. If an

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override request is received, the local computer
transitions to state 109.

Additionally, if the local computer is in
state 108, and an initialization broadcast is received,
5   the rules described above with respect to state 104 may
be applied to determine if the newly initialized
computer would be a better server. If so, the local
computer may optionally transition to state 106,
shutting down as server, and allowing the newly-
10   initialized computer to become the active server.

In state 109, the local computer (which is
also the active server) handles receipt of an override
request. A message is displayed on the screen asking
the user of the local computer if he or she approves
15   the override request. If all users of active computers
on the LAN agree to the request, then the local
computer shuts down the gateway software, stops acting
as the server, and transitions back to state 101. If
any user on the LAN refuses to allow the override
20   request, or a timeout occurs, then the local computer
returns to state 108, and remains the active server.

State 110 handles a user-initiated override
request. When the user of the local computer requests
that the local computer become the active server,
25   approval is needed from all other active computers on
the LAN. State 110 broadcasts an override request
message, and waits to hear back from all of the active
computers on the LAN, or for a timeout to occur. If
all of the other active computers on the LAN approve
30   the override request, then the local computer
transitions to state 105 and becomes the active server.
Otherwise, the local computer informs the user that the

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override request was unsuccessful, and returns to state
101.

State 111 handles the receipt of an override
request when the local computer is in state 101. A
5   message is displayed on the screen asking the user if
he or she approves the override request. If the user
approves of the request, the local computer broadcasts
approval. If the user disapproves or a timeout occurs,
the local computer broadcasts disapproval of the
10   request. If all of the active computers on the LAN
send approval, the request has been approved, and the
local computer transitions to state 102, to search for
the new server. Otherwise, the local computer returns
to state 101.

15   Referring now to FIG. 3, a state diagram of
an alternative preferred embodiment of the server
selection agent software of the present invention is
described. Server selection agent software 30 may be
more preferred than server selection agent software 20
20   of FIG. 2, since it is somewhat simpler, and more
robust handling errors. Server selection agent
software 30 executes on every computer on a LAN, and
may be either a part of the operating systems of the
computers on the LAN or may be a separate application.
25   Server selection agent software 30 starts executing in
state 200 when the operating system is started.

State 200 is an initialization state, in
which server selection agent software 30, executing on
a local computer, initializes itself and determines the
30   capabilities of the active computers on the LAN. The
information on the capabilities of the active computers
on the LAN preferably comprises information on whether
each computer has a modem or other communication device

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with which it can communicate with a wide area network,
the speed of any modems or communication devices, and
information on the overall system speed. This
information may be gathered in a manner similar to that
5   described hereinabove with reference to FIG. 2. When
initialization is finished, the local computer
transitions to state 201.

In state 201, the local computer searches for
an active server. This may be achieved by the local
10   computer broadcasting a network message to all
computers on the LAN requesting that they respond if
they are the active server. If another computer on the
LAN responds that it is the active server, then the
local computer applies a set rules to determine if the
15   local computer would be a better server than the
current active server. The rules that are used to make
this determination, for example, may be identical to
the rules described with reference to state 104 of FIG.
2.

20   If, based upon application of the foregoing
rules, it is determined that the local computer would
be a better server, then the local computer broadcasts
a "VoteReq" message to all of the computers on the LAN,
and transitions to state 203. Otherwise, if the rules
25   determine that the local computer is not better than
the active server, then the local computer transitions
to state 202.

If no computer on the LAN responds that it is
the active server, then the local computer transitions
30   to state 203 to choose a server. Additionally, if an
error condition occurs, such as if more than one
computer responds that it is the active server on a LAN
that can have only one active server, state 202 may

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force all of the systems on the LAN to choose a new
server. This is achieved by broadcasting a "ReVoteReq"
message to all of the computers on the LAN, and
transitioning to state 203.

5   State 202 is a standby state, in which server
selection agent software 30 waits for some event, such
as a broadcast message from other computers on the LAN,
or a timeout condition, to cause it to transition to a
different state. If a "Shutdown" message, a "ReVoteReq"
10   message, a "VoteReq" message, or a "ForceToBeServer"
message (described hereinafter) is received while the
local computer is in state 202, the local computer
transitions to state 203 to select a new server.

          Additionally, the local computer expects to
15   receive an "Alive" message from the active server at
regular intervals. If such a message is not received
for a specified length of time, a timeout condition
occurs. A timeout condition typically indicates that
the active server is no longer functioning due to some
20   problem, such as if the active server freezes or
crashes. When a timeout condition occurs, the local
computer transitions to state 203, to select a new
server. Optionally, the local computer may also
broadcast a "ReVoteReq" message to all the active
25   computers on the LAN, to let all the computers know
that a new server should be selected.

          It should be noted that the timeout condition
of state 202 operates in a very different manner than
the timer event described with reference to state 101
30   of FIG. 2. The timer event causes a kind of "polling"
to occur, in which each of the computers searches for
the server at regular intervals. Using the timeout
event of state 202, the computers do not repeatedly

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search for a server. Instead, the active server
periodically broadcasts "Alive" messages to let the
computers on the LAN know that it is still functioning.
It will be evident to one skilled in the art that the
5   "polling" mode described with reference to FIG. 2 could
be applied to the software shown in FIG. 3, or the
timeout mode described with reference to FIG. 3 could
be applied to the software shown in FIG. 2.

State 202 also handles user initiation of an
10   override request. If the user of the local computer
decides that he or she wants the local computer to
become the server, an override request may be initiated
from state 202. If the user initiates an override
request, the local computer broadcasts a
15   "ForceToBeServer" message, and transitions to state
203.

In state 203, a new server is selected. If
the local computer reaches state 203 because there was
no active server on the network, due to a timeout, due
20   to an error, or because a "ReVoteReq" message was
received, then the local computer applies a set of
rules to determine which of the active computers on the
LAN should become the server. The rules applied may be
identical to the rules described hereinabove with
25   reference to FIG. 2. If the rules determine that the
local computer should become the active server, then
the local computer transitions to state 204.
Otherwise, if the rules determine that the local
computer should not become the active server, the local
30   computer transitions to state 202. If no computer on
the LAN can become the active server (e.g. because none
of the active computers on the LAN has a modem), then

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an error message is displayed, and the local computer
transitions to state 202.

If the local computer reaches state 203 due
to a "VoteReq" message, a "Shutdown" message, or a
5   determination that the local computer would be a better
server than the active server, then an additional step
is required. For a vote to occur in these conditions,
the consent of the users of other active computers on
the LAN is needed. A message will be displayed on each
10 of the computers on the LAN, requesting the user's
consent. If consent is given by all of the computers
on the LAN, then the process of selecting a server will
proceed, as described hereinabove. If consent is not
given, then the active server will remain active, and
15 the other computers on the LAN will return to state
202.

It should be noted that this is a different
procedure than is used in the software described with
reference to FIG. 2, since permission is needed for the
20 active server to shutdown, or for a computer that is
better than the active server to become the active
server. In the software described with reference to
FIG. 2, no permission from other users is needed to
perform these functions. It will be evident to one
25 skilled in the art that a permission scheme similar to
the one described with reference to state 203 also
could be applied to the software of FIG. 2. Similarly,
state 203 could be altered so that these functions are
performed without permission of the users of other
30 computers.

State 203 also handles override requests. If
the local computer reaches state 203 due to a user
initiated override request, or a "ForceToBeServer"

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message, then consent is needed before the computer
that made the request may become the active server.
Each of the active computers on the LAN displays a
message requesting consent from the user for the
5   override request. If consent is given by the users of
all of the active computers on the LAN, then the
computer that made the override request becomes the
server, by transitioning to state 204, while the other
computers on the LAN transition to state 202, and
10   become clients of the new server. Otherwise, if
consent is not given by all of the users of active
computers on the LAN, then the active server remains
active, and all of the other computers on the LAN
transition to state 202.

15   The local computer enters state 204 if it is
decided through the server selection process that the
local computer should become the active server. In
state 204, the gateway software is started. The
gateway software preferably comprises modified gateway
20   software, but may also comprise unmodified gateway
software, as discussed hereinabove with reference to
FIG. 2. If the gateway software starts successfully,
the local computer transitions to state 205.
Otherwise, if the gateway software fails to start, the
25   local computer transitions to state 206.

          State 205 is a state in which server
selection agent software 30 interacts with the gateway
software. If a remote or local Internet request is
received and the server is not already connected to the
30   ISP, a connection is established. When notice is
received that the operating system is shutting down
(e.g. because the user is shutting down the computer),
the local computer transitions to state 207. If a

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"VoteReq" message or a "ReVoteReq" message is received,
then the local computer transitions to state 203.
Additionally, the local computer (that is also the
active server) periodically broadcasts "Alive" messages
5   to all of the other computers on the LAN, to let the
other computers know that the active server is still
functioning.

In state 206, an error message is displayed,
informing the user of the local computer that the
10 gateway software failed to start. The local computer
then transitions to state 202. Optionally, the local
computer may remove itself from the set of computers
that may become the active server prior to switching to
state 202. Additionally, the local computer may
15 optionally broadcast a "ReVoteReq" message, to let the
other computers on the LAN know that an error has
occurred, and it is necessary to select a new server.

In state 207, the local computer broadcasts a
"Shutdown" message, and waits for the Operating system
20 to shut down. It may be necessary for the local
computer to refuse to shut down, and to return to state
205 if the users of the other active computers on the
LAN refuse to give their consent for the local computer
to stop being the active server.

25   Although preferred illustrative embodiments
of the present invention are described above, it will
be evident to one skilled in the art that various
changes and modifications may be made without departing
from the invention. For example, if there are multiple
30 telephone lines, the server selection agent software
may be altered to handle more than one active server,
and the state that searches for active servers may
determine which or the active servers to use based on

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the load at each active server. Additionally, if there
are multiple active servers, each computer may route
network traffic through more than one active server to
increase network bandwidth.

5   Additionally, the mechanism for obtaining
consent for an override, or for other functions that
require consent could be changed so that a simple
majority is needed, or so that only the approval of the
active server, or of a network administrator is needed.

10 As discussed above, the server selection rules may be
altered to change the criteria used to determine which
computer is selected as the active server.

              It is intended in the appended claims to
cover all such changes and modifications that fall

15 within the true spirit and scope of the invention.

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What Is Claimed Is:

      1.   A method of sharing a connection to a wide area network among a plurality of computers connected to a local area network, the method comprising:

      (a) determining that a subset of the plurality of computers are available for use as a server;

      (b) automatically selecting one of the subset of the plurality of computers to become the server; and

      (c) repeating steps (a) and (b) when the server becomes unavailable.

      2.   The method of claim 1, further comprising:

      establishing a connection between the server and the wide area network; and

      routing network traffic through the server to the wide area network.

      3.   The method of claim 1, wherein the wide area network comprises the Internet.

      4.   The method of claim 2, wherein routing network traffic through the server to the wide area network comprises a step of running gateway software on the server.

      5.   The method of claim 4, wherein the gateway software comprises network address translation software.

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6.   The method of claim 4, wherein the gateway software comprises proxy server software.

7.   The method of claim 1, wherein determining that a subset of the plurality of computers are available for use as a server further comprises gathering information on selected capabilities of active ones of the plurality of computers.

8.   The method of claim 7, wherein automatically selecting one of the subset of the plurality of computers to become the server comprises evaluating a set of rules to determine which of the subset should become the server.

9.   The method of claim 8, wherein evaluating the set of rules comprises evaluating the information on selected capabilities of active ones of the plurality of computers.

10.   The method of claim 9, wherein the selected capabilities include a communication speed of each of the active ones of the plurality of computers, and evaluating the set of rules comprises evaluating the communication speed.

11.   The method of claim 9, wherein the selected capabilities include a system speed of each of the active ones of the plurality of computers, and evaluating the set of rules comprises evaluating the system speed.

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12.   The method of claim 8, wherein the method further comprises reevaluating the set of rules when an additional computer becomes active.

13.   The method of claim 1, wherein determining that a subset of the plurality of computers are available for use as a server further comprises determining which of the plurality of computers are powered on.

14.   The method of claim 1, wherein determining that a subset of the plurality of computers are available for use as a server further comprises determining which of the plurality of computers has access to a communication device capable of establishing a connection to the wide area network.

15.   The method of claim 1, wherein the method further comprises permitting a user of one of the subset of the plurality of computers to override automatic selection of the server.

16.   The method of claim 15, wherein permitting a user to override automatic selection of the server further comprises overriding automatic selection of the server only if the users of all of the subset of the plurality of computers consent.

17.   Apparatus for selecting a computer on a local area network to become a server to permit sharing of a connection to a wide area network among a plurality of computers connected to a local area network, the apparatus comprising a local computer

connected to the local area network, the local computer
programmed to:

    (a) determine that a subset of the plurality
of computers are available for use as a server;

    (b) automatically select one of the subset of
the plurality of computers to become the server; and

    (c) repeat steps (a) and (b) when the server
becomes unavailable.

    18. The apparatus of claim 17, wherein the
local computer is further programmed to:

    establish a connection between the local
computer and the wide area network, and become the
server, if the local computer was selected to become
the server; and

    route network traffic through the server to
the wide area network.

    19. The apparatus of claim 17, wherein the
local computer is further programmed to inform other
active ones of the plurality of computers that the
server is unavailable if the local computer is the
server, and the local computer is becoming unavailable.

    20. The apparatus of claim 17, wherein the
wide area network comprises the Internet.

    21. The apparatus of claim 17, wherein the
local computer is further programmed to execute gateway
software to route network traffic to the wide area
network, if the local computer is the server.

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22.   The apparatus of claim 21, wherein the gateway software comprises network address translation software.

23.   The apparatus of claim 21, wherein the gateway software comprises proxy server software.

24.   The apparatus of claim 17, wherein the local computer is further programmed to gather information on selected capabilities of active ones of the plurality of computers.

25.   The apparatus of claim 24, wherein the local computer is programmed to automatically select one of the subset of the plurality of computers to become the server by evaluating a set of rules to determine which of the subset should become the server.

26.   The apparatus of claim 25, wherein evaluating the rules comprises evaluating the information on selected capabilities of the active ones of the plurality of computers.

27.   The apparatus of claim 26, wherein the selected capabilities include a communication speed of each of the active ones of the plurality of computers, and the evaluating the set of rules comprises evaluating the communication speed.

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28. The apparatus of claim 26, wherein the selected capabilities include a system speed of each of the active ones of the plurality of computers, and evaluating the set of rules comprises evaluating the system speed.

29. The apparatus of claim 25, wherein the local computer is further programmed to reevaluate the set of rules when an additional computer becomes active.

30. The apparatus of claim 17, wherein the local computer is programmed to determine that a subset of the plurality of computers are available for use as a server by determining which of the plurality of computers are powered on and have access to a communication device capable of establishing a connection to the wide area network.

31. The apparatus of claim 17, wherein the local computer is further programmed to permit a user of one of the subset of the plurality of computers to override automatic selection of the server.

32. The apparatus of claim 31, wherein the local computer is programmed to permit a user to override automatic selection of the server only if the users of all of the subset of the plurality of computers consent.

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33. Apparatus for sharing a connection to a
wide area network among a plurality of computers, the
apparatus comprising:
        a local area network interconnecting the
plurality of computers; and
        a communication line permitting a connection
between at least one of the plurality of computers and
the wide area network;
        wherein each one of the plurality of
computers comprises a processor programmed to:
        (a) determine that a subset of the plurality
of computers are available for use as a server;
        (b) automatically select one of the subset of
the plurality of computers to become the server; and
        (c) repeat steps (a) and (b) when the server
becomes unavailable.

34. The apparatus of claim 32, wherein the
processor of each one of the plurality of computers is
further programmed to:
        establish a connection between the computer
and the wide area network, and become the server, if
the computer was selected to become the server; and
        route network traffic through the server to
the wide area network.

35. The apparatus of claim 33, wherein the
local area network comprises a network hub, and each of
the plurality of computers is connected to the local
area network through the network hub.

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36.   The apparatus of claim 33, wherein at least one of the plurality of computers comprises a communication device coupled to the communication line.

37.   The apparatus of claim 36, wherein the communication device comprises a modem, and the communication line comprises a public telephone line.

38.   The apparatus of claim 36, wherein the communication device comprises a cable modem, and the communication line comprises a cable line.

39.   The apparatus of claim 36, wherein the communication device comprises a digital subscriber line modem, and the communication line comprises a digital subscriber line.

40.   The apparatus of claim 36, wherein the communication device comprises an ISDN modem, and the communication line comprises an ISDN line.

41.   The apparatus of claim 33, wherein the wide area network comprises the Internet.

42.   The apparatus of claim 33, wherein the server executes gateway software to route network traffic to the wide area network.

43.   The apparatus of claim 42, wherein the gateway software comprises network address translation software.

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44.   The apparatus of claim 32, wherein the gateway software comprises proxy server software.

45.   The apparatus of claim 33, where the local area network comprises network connections chosen from a set consisting of 10Base-T, 100Base-T, telephone lines, power lines, wireless infrared communications, and wireless RF communications.
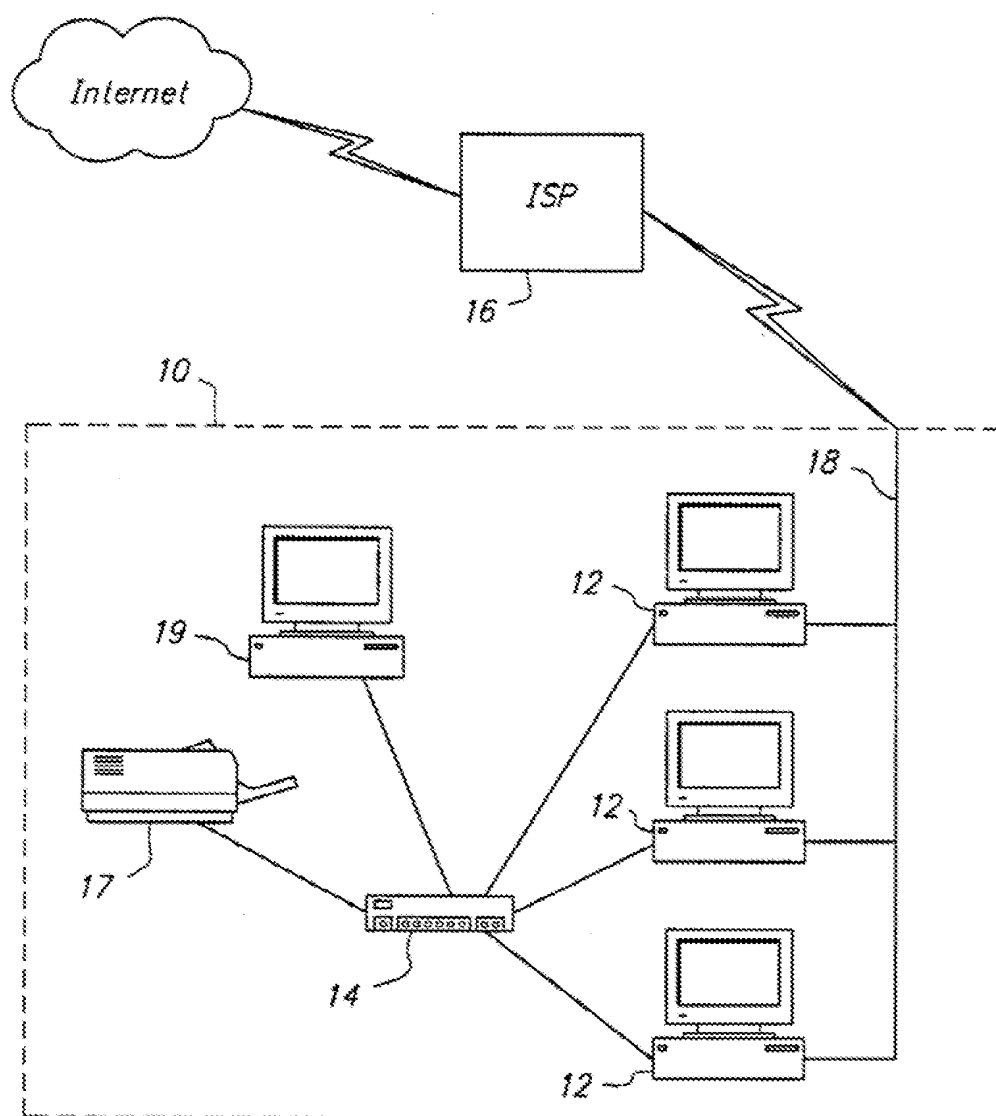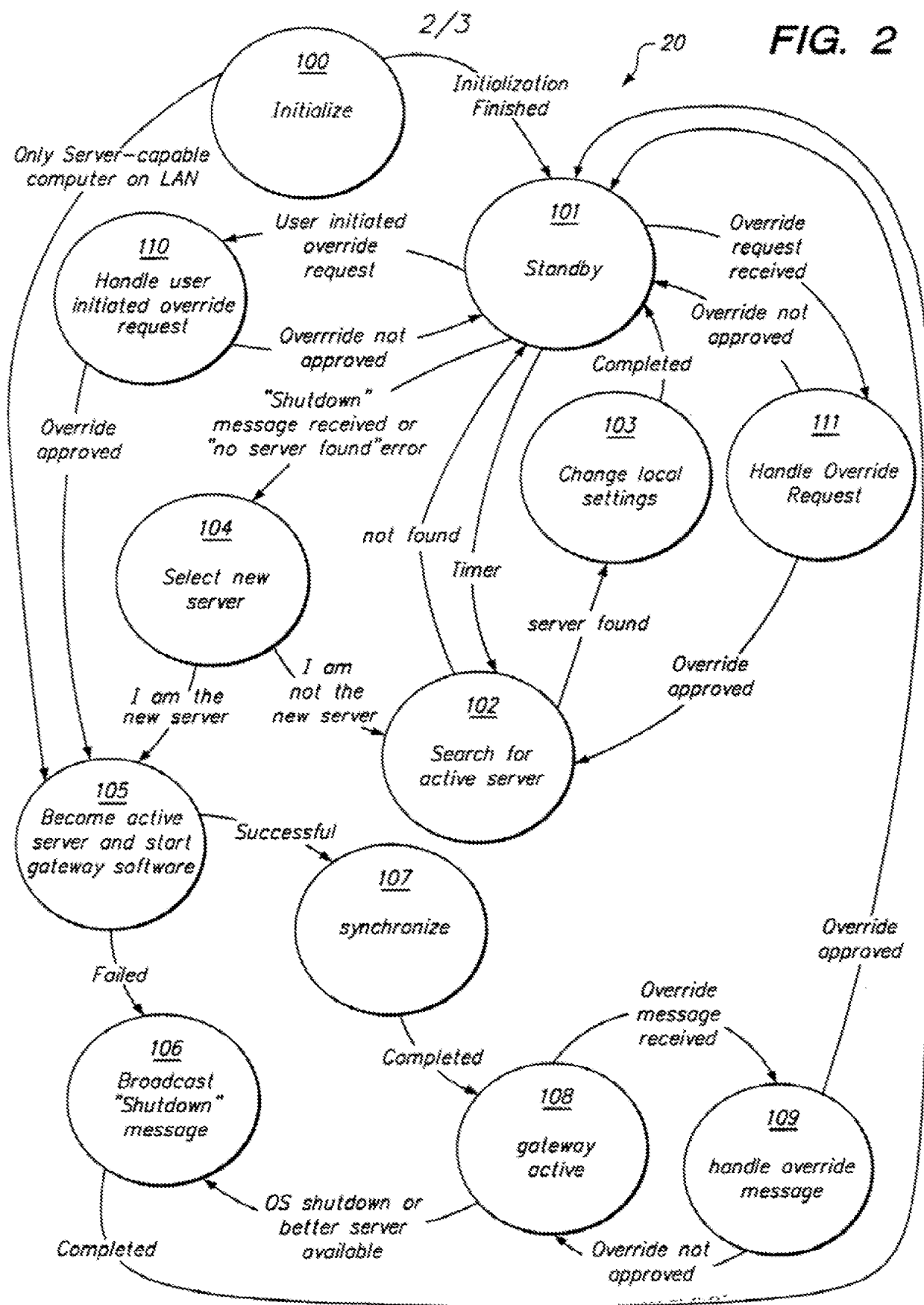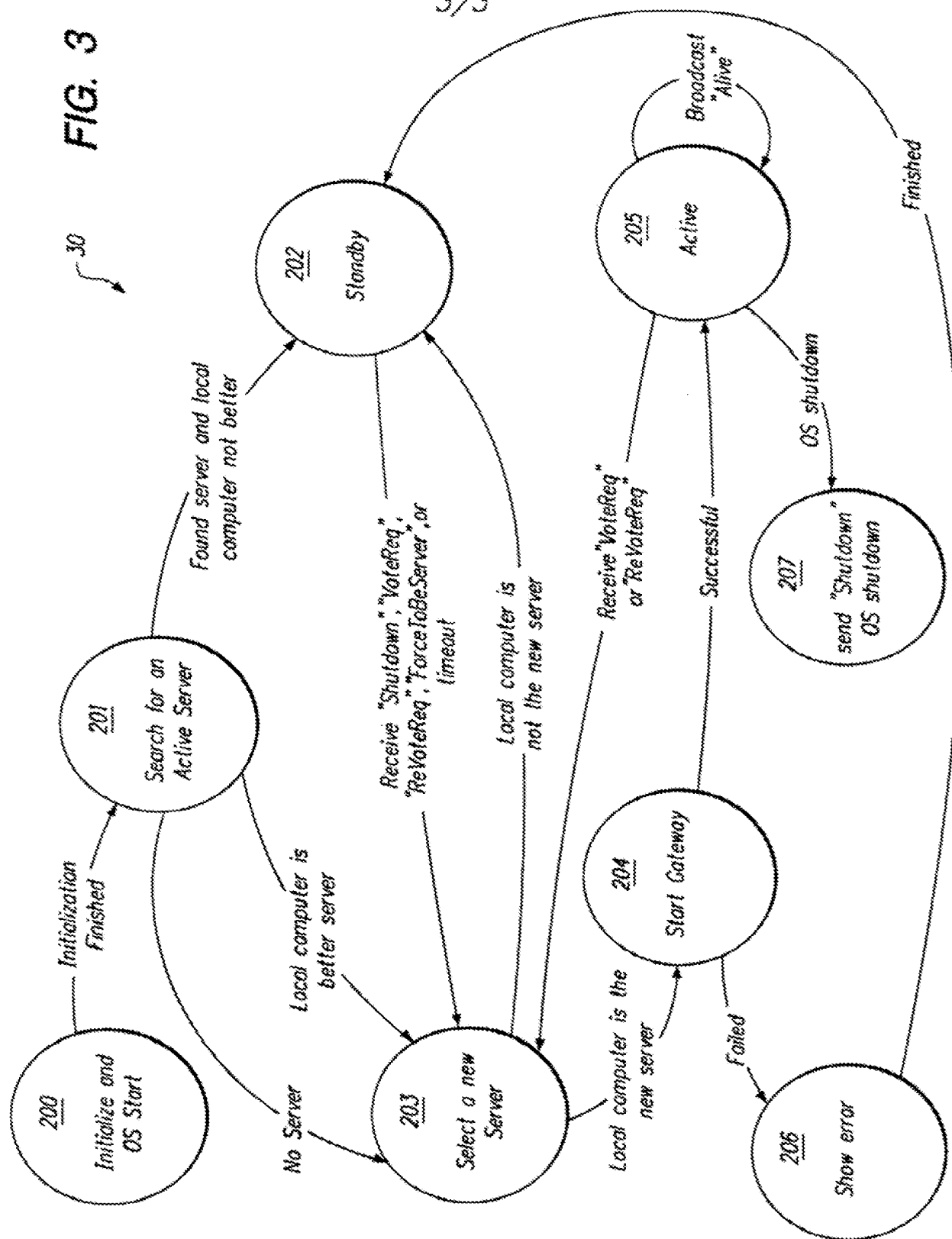
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FIG. 1

FIG. 2

FIG. 3

30

200 Initialize and OS Start

Initialization Finished

201 Search for an Active Server

No Server

Local computer is better server

Found server and local computer not better

202 Standby

Receive "Shutdown", "VoteReq", "ReVoteReq", "ForceToBeServer", or timeout

Local computer is not the new server

203 Select a new Server

Local computer is the new server

204 Start Gateway

Successful

Failed

206 Show error

Finished

Receive "VoteReq" or "ReVoteReq"

205 Active

Broadcast "Alive"

OS shutdown

207 send "Shutdown" OS shutdown

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : G06F 15/16, 15/177
US CL   : 709/220, 221, 238,249,250

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 709/220, 221, 238,249,250

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

RFC Database

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WEST, STN, DIALOG

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	US 5,862,348 A (PEDERSEN) 19 January 1999, col. 4 line 20 et seq and col. 5 lines 13-19.	1,17,33
A	(SRISURESH et al) Load Sharing using IP Network Address Translation Network Working Group August 1998	1-45

☐ Further documents are listed in the continuation of Box C.   ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance		
"E"	earlier document published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed	"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 NOVEMBER 1999	**03 DEC 1999**

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer MEHMET GECKIL
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